Overview of International Programs for Identification and Evaluation of Technologies for DOE-EM

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Abstract

In 1990, the U.S. DOE and MINATOM established a Joint Coordinating Committee for Environmental Restoration and Waste Management (JCCEM). The principal purpose of the JCCEM is to oversee and manage activities conducted under the Memorandum of Cooperation. This includes collaborative projects that involve scientists from Russian academic and governmental laboratories as well as scientists from U.S. National Laboratories and other research institutions. These projects cover a wide spectrum of nuclear waste management and disposition issues. More than a dozen workshops and demonstrations on newly developed methods and technologies are conducted annually under JCCEM auspices, both in Russia and the United States.

Based on the success of the JCCEM, several other joint coordinating committees have been established internationally. One of these is the Joint Coordinating Committee for Environmental Systems (JCCES) established between the U.S. DOE Office of Environmental Management and the Polish Institute for Ecology of Industrial Areas (IETU), which is located in Katowice, Poland. The JCCES is in its sixth year of operation and supports research projects in the areas of removal or stabilization of organic and inorganic contamination in soils. These activities have emphasized biological technologies (e.g., microbial bioremediation and phytoremediation) that take advantage of the skills and capabilities of the IETU and the research opportunities present in southern Poland. To date, these projects have been conducted for the Subsurface Contaminants Focus Area (SCFA) in cooperation with the Savannah River Technology Center.

The ultimate goals of these joint coordinating committees are to identify, evaluate and return to the U.S. for deployment, technologies that have the potential to benefit DOE in its environmental remediation mission. The Institute for International Cooperative Environmental Research (IICER) at Florida State University manages these international programs for DOE. The IICER provides technical coordination, logistical support and project management to the joint coordinating committees. This paper provides an overview of some of the accomplishments made during FY 2001.

I. JCCEM Technology Development & Deployment: Russia

Introduction

In 1990, the U.S. Department of Energy (DOE) and the Ministry of Atomic Energy for the Russian Federation (MINATOM) signed a Memorandum of Cooperation (MOC) in the area of Environmental Restoration and Waste Management. MOC activities are managed by the Joint Coordinating Committee for Environmental Restoration and Waste Management (JCCEM). The JCCEM meets annually to review and approve proposals, assess program progress, make determinations concerning the protection of intellectual property rights (IPR) and data transmission and to determine the level of effort for future activities. The 11th JCCEM meeting was conducted on 3-4 September 2001 in St. Petersburg, Russia.

The JCCEM Co-Chairs representing the U.S. and Russia are responsible for implementation of the JCCEM program. Currently the JCCEM is chaired by Mr. Gerald G. Boyd, Deputy Assistant Secretary, Science and Technology, Office of Environmental Management, U.S. Department of Energy, and by Dr. Valery A. Lebedev, Deputy Minister, Ministry of Atomic Energy of the Russian Federation.

Since its inception, the JCCEM has supported a number of collaborative projects involving scientists from Russian academic and governmental laboratories as well as scientists from U.S. National Laboratories. These projects cover a wide spectrum of nuclear waste management and disposition issues as well as subsurface radioactive contaminant transport problems. More than a dozen workshops and demonstrations on newly developed methods and technologies are conducted annually under JCCEM auspices both in Russia and the United States. The JCCEM has been successful in its mission and has served as a model for other, more recently established joint coordinating committees.

Active participation by the DOE Office of Environmental Management (EM), Office of Science and Technology (OST) (see www.em.doe.gov/) in the JCCEM program ensures that the critical needs of the EM Focus Areas are addressed. All JCCEM projects are reviewed and evaluated by Focus Area technical staff for scientific merit, applicability to key DOE site needs and applicability to the expressed needs of a DOE user. Funding for this cooperative work with Russia comes from the DOE Focus Areas. Managing this work through MINATOM provides improved access to needed technical information, early guidance in the development of cost-saving technologies, continued dialogue among technical specialists and possible access to commercial opportunities with Russia. Florida State University (FSU), through its Institute for International Cooperative Environmental Research (IICER) (see www.iicer.fsu.edu) and the Science Applications International Corporation (SAIC), under contract to FSU, provide technical and organizational support to DOE for the JCCEM program. Through direct contact with the Russian and U.S. principal investigators and their colleagues, the IICER assures that JCCEM cooperative projects proceed on schedule and that technical issues are resolved quickly and effectively.

Success Stories and Recent Developments

This section presents some of the recent achievements of the JCCEM program.

Deactivation and Decommissioning Focus Area (DDFA)

At the request of the Deactivation and Decommissioning Focus Area (DDFA), FSU assists in the identification of Russian D&D technologies as candidate deployment technologies for the DDFA. FSU provides technical and logistical assistance to the DOE Large-Scale Demonstration and Deployments Program (LSDDP) for evaluating the most promising Russian technologies.

The Gamma Locating Device (GLD, Fig 1) developed by the Russian Research and Development Institute of Construction Technology (NIKIMT), was successfully deployed at the Idaho National Engineering and Environmental Laboratory on July 31, 2001. The distinguishing features of this device are that it is untethered and remotely transmits live video, radiation and isotopic measurements via radio frequency to operators at remote control stations. Different levels of radioactivity appear on a computer monitor as color-coded maps that allow technicians to pinpoint highly contaminated areas. Use of the GLD can save weeks of time by eliminating the need to send samples to a laboratory for analysis. By using the GLD, fewer workers are required to enter contaminated areas, thus reducing their exposure to radiation. More information can be found at http://id.inel.gov/lsddp. The INEEL Technical Demonstration Summary Sheet is published at

http://id.inel.gov/lsddp/GLD_Fact_Sheet_rev_4.pdf and

http://id.inel.gov/lsddp/IID_Factsheetrev2.pdf.

Figure 1. The Russian Gamma Locator Device mounted on a radio-controlled INEEL robot (Irobot ATRV-Jr).

The demonstration & deployment of the GLD was well publicized by INEEL to the mass media (see, e.g., refs. [1, 2]).

Three additional Russian D&D technologies are planned to be demonstrated in FY02:

1. Deactivation of radioactive contamination through removable coatings, NIKIMT, Moscow.

2. Deep decontamination of plutonium glove boxes (electrochemical method for removal of strongly fixed contaminants), VNIPIET, St. Petersburg.

3. Decontamination of plutonium glove boxes (foam method for removal of weakly fixed contaminants), VNIPIET, St. Petersburg.

The demonstration/evaluation of five of NIKIMT s strippable and non-strippable coatings will be conducted at the HCET (Hemispheric Center for Environmental Technology), Florida International University. The demonstration of the Electrochemical and Foam Decontamination technologies will be conducted at the Khlopin Radium Institute in St. Petersburg, Russia during FY02. The Los Alamos LSDDP has prepared a comprehensive test plan for the demonstration of these technologies. FSU is responsible for coordinating Russian participation in these technology demonstrations.

In FY01, the Deactivation and Decommissioning Focus Area decided to extend the U.S.-Russian cooperation on basic and applied science research and development activities. FSU developed a package of documents which facilitated this New Call for Proposals focused on D&D issues. This package of documents was sent to MINATOM for distribution. Russian institutions and production sites submitted seventeen proposals. Five technologies were selected for cooperative R&D under the auspices of the JCCEM Program. These five technologies are the following:

1. Technology for Dust Suppression and Radioactive Contamination Localization on Concrete, Reinforced Concrete, and Steel Surfaces by Deposition of a Thin Film of a Fluoroepoxy Coating, DC IIE Daymos, Ltd. , St. Petersburg, Russia.

2. Biotechnology for Decontamination of Surfaces Coated with Paint and Varnish, Klopin Radium Institute, St. Petersburg, Russia.

3. Use of Film Forming Compositions for Decontamination and Worker Protection, Mayak Production Association, Ozersk, Russia.

4. Development of Water Jet Cutting Technology, SUE "Spektr", Moscow, Russia.

5. Automated Sorption-Spectrometric System for Continuous Monitoring of Gamma Emitting Nuclides in Air-Gas Discharges, Institute of Atomic Reactors, Dimitrovgrad, Russia.

For additional information about D&D activities conducted under the auspices of the JCCEM Program visit the JCCEM website www.jccem.fsu.edu.

- **Efficient Separations Cross Cutting Program**

Chemical separations in nuclear radiochemistry science and technology are used for the separation of mixtures of materials according to certain properties. The chemical separation of nuclear materials into their chemical components is central to DOE s efforts to significantly reduce the volume of high-level nuclear waste generated during the production of nuclear weapons and from the production of nuclear energy. This waste is associated with serious long-term health risks, enormous environmental contamination and potential contamination of unpolluted areas. Reduction of the nuclear waste to manageable levels is essential for nuclear energy to remain an option for meeting the energy needs of the future. The separation of radionuclide species in nuclear waste also makes it possible to treat long-lived radionuclides differently from shorter-lived ones, resulting in more options for present and future waste management (see, e.g., [3, 4]). The field of separations was identified as an area of cooperation at the first JCCEM meeting in Moscow in 1990. At that time, MINATOM began constructing a full-scale chemical separations facility at the Mayak Production Association, and DOE was exploring methods for treating HLW streams at the Idaho, Hanford and Savannah River sites.

The Cobalt Dicarbollide Universal Extraction (UNEX) Technology [5-10] is an example of successful international cooperation through the JCCEM Program. UNEX is designed for processing and treating high-level wastes. This technology is being developed cooperatively at both Russian and DOE institutions for application in both countries within the framework of the JCCEM Program. UNEX makes it possible to remove cesium, strontium and actinides from acidic waste in a single-step process. It is a promising separations technology with potential application at several DOE sites, including the Idaho National Engineering and Environmental Laboratory (INEEL). Currently, UNEX is included in the INEEL Environmental Impact Statement as an alternative to the baseline technology. For more information concerning the UNEX Technology see References 3-8.

Figure 2. Russian scientists observe UNEX tests in the hot cell at INEEL.

Fundamental and Applied Chemistry of Technetium [11-13]. Technetium-99 is the dominant fission product radionuclide after about 1,000 years of cooling (in terms of total activity) and is present in Savannah River Site (SRS) tank wastes. The observation of relatively high concentrations of insoluble technetium in the SRS tank waste sludge was not expected and indicates a serious deficiency in the knowledge of the disposition of this important radioactive element in alkaline wastes, not only at SRS but also, potentially, at Hanford. The Institute of Physical Chemistry conducted research on the fundamental and applied chemistry of technetium in SRS wastes in order to provide a sound technical understanding of the behavior of technetium in this system. The results of this JCCEM cooperative project on Technetium Disposition and Leaching from Savannah River Site Tank Waste were presented at the 12th Symposium on Separation Science and Technology for Energy Applications, Gatlinburg, Tennessee, 15-18 October 2001.

- **High Level Waste Tank Remediation Focus Area**

DOE's Tanks Focus Area (TFA) develops technologies to safely and efficiently remediate radioactive waste stored in underground tanks at four sites nationwide. This work is conducted by leveraging resources and working with a team of experts from industry, national laboratories, consulting firms, universities, stakeholders and DOE sites.

The Russian Pneumatic Pulsating Pump and Monitor (Fig. 3) is a technology developed by the Mining and Chemical Combine (Zheleznogorsk, Russia) for the retrieval of high-level waste (HLW) from storage tanks at DOE and MINATOM sites. The Pulsating Mixer Pump is designed to mobilize and retrieve sludge waste using three pumps: a jet pump, a mixing pump and a transfer pump. A key benefit of the pulsating mixer pump is that additional liquids are not introduced into the tank during the mobilization and retrieval efforts.

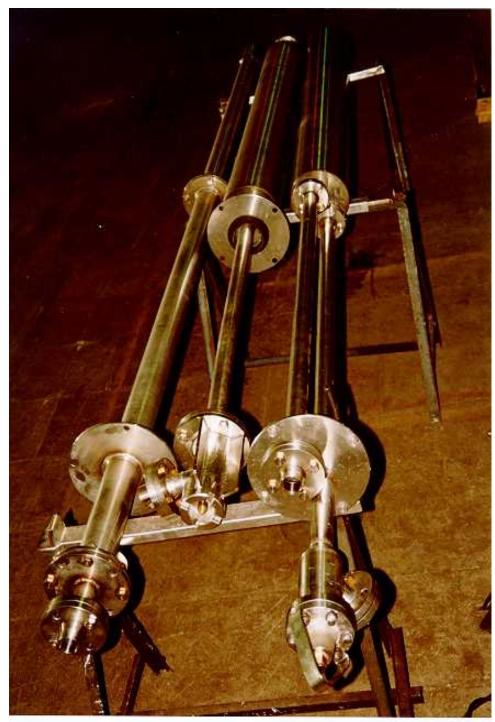

Figure 3. The Russian Pneumatic Pulsating Pump.

The pulsating pump was demonstrated successfully at the Quarter-Scale Tank Test Facility at Hanford in July of 1997 in order to determine the capabilities, limitations, and suitable applications of the tank retrieval equipment at U.S. sites. As a result of these successful U.S. and Russian demonstrations, three sets of this pumping equipment were procured by DOE in November of 1998. The pump and monitor were successfully deployed within Oak Ridge tanks in January of 2001. For more information see (www.pnl.gov/tfa/techphotos.stm#rpmp)

A Russian Technology for Chemical Decontamination of Tanks that uses oxalic acid and other chemicals to remove the hardened sludge and residual contaminants from waste tanks was developed by the Khlopin Radium Institute (St. Petersburg, Russia) and the Mining and Chemical Combine (Zheleznogorck, Russia). The primary goal of this project is to adjust this technology to the high-level sludge wastes accumulated in DOE tanks. Extensive tests on simulated DOE sludges are to be conducted at these Russian institutions. It is expected that this project will result in the recommendation of candidate processes for cleaning residue from stainless steel high-level waste tank walls at Idaho National Environmental and Engineering Laboratory and in the development of the nuclear criticality safety basis to allow the use of oxalic acid to chemically dissolve high-level waste sludge at the Savannah River Site (SRS).

The Plasmatron with Induction Cold Crucible Melter (PICCM) Technology, developed by the Institute of Chemical Technology, is a pilot-scale apparatus for the treatment of solid mixed radioactive wastes. In laboratory and pilot scale tests, the device immobilized mixed waste streams at both the Diagnostic Instrumentation and Analysis Laboratory (DIAL) at Mississippi State University and the Georgia Institute of Technology (see, e.g., [11]). The PICCM continues to be used at DIAL for spent fuel applications testing.

Russian Induction-Heated Cold Crucible Melter (ICCM) Technology has been developed to evaluate the Russian Induction-Heated Cold-Crucible Melter for potential applicability to U.S. DOE site needs. This project will be based on a thorough review of information on the technology, an evaluation of compatibility of ICCM operations to U.S. waste and a demonstration of the ICCM on simulated DOE wastes. Two Russian institutions, Khlopin Radium Institute (St. Petersburg) and the Moscow Scientific and Industrial Association Radon (Moscow Region, Russia), were contracted to conduct these projects in FY01-02.

- **Nuclear Materials Focus Area**

The Porous Crystalline Matrix for Stabilizing Actinide Solutions (GUBKA) Technology was developed by the Khlopin Radium Institute, the Mining and Chemical Combine, and the Institute of Chemistry and Chemical Technology. The GUBKA material is manufactured from coal power plant fly ash for the stabilization of actinide solutions at ambient temperature. This technology currently is being considered by several DOE sites for applicability to stabilization of laboratory wastes and the adsorption of radioactive acidic wastes. Laboratory tests are being conducted at the Fernald Site and the INEEL to stabilize laboratory waste solutions containing both hazardous and radioactive components (see Fig.4). At the conclusion of this process, this project will be considered a successful deployment as the stabilized wastes are shipped for permanent storage. For more information on the GUBKA Technology visit the web site emi-web.inel.gov/NMFA/Technologies.htm.

Figure 4. Bagged blocks after the radionuclides are sorbed into the Gubka blocks.

- **Characterization, Monitoring, and Sensor Technology Cross Cutting Program (CMST)**

Contaminant Transport and Site Characterization Modeling Activities [15-21] have been conducted by Russian specialists from the Mayak Production Association (Ozersk), Siberian

Chemical Combine (Seversk, Tomsk Region), Hydrospetzgeologiya (Moscow), Designing and Research Institute of Production Engineering (VNIPIPromtechnologiya) (Moscow), and scientists from the DOE Environmental Measurements Laboratory and the Pacific Northwest National Laboratory. These efforts are assisting DOE in the development of an inverse transient model of contaminant migration at the Hanford site. The Mayak Production Association and the Siberian Chemical Combine have provided access to extensive databases of radioactive contaminant transport.

Mayak project: An extensive computer model of the Mayak site was developed to include surrounding land areas and water bodies, and the geological formations underlying the site. This model has recently been adapted for the Hanford site, where an expanding plume of liquid radioactive wastes has escaped from storage sites and may pose a threat to the Columbia River Basin and surrounding environment. The application of this model to the Hanford site will assist in developing a comprehensive plan for addressing this potential threats to the Columbia River Basin and surrounding environment.

Tomsk project (Siberian Chemical Combine): The goal of this project is to develop a system of flow and contaminant transport models. These models will be applied to evaluate the safety of deep injection and the effectiveness of proposed monitoring. The models also will be used to evaluate proposed remedial actions for assessing radiation exposure resulting from the operation of the deep injection site. The other objective of the project is to use this model as a method for understanding the nature of radionuclide transport in complex subsurface systems. The extensive database developed at this Russian site will provide valuable confirmatory information against which the models and monitoring systems will be tested and evaluated.

Evaluation of Characterization and Monitoring Technologies and Numerical Modeling of the Vadose Zone Flow and Contaminant Transport at Selected Field Sites in Russia. [22]. Field characterization and monitoring at sites across the DOE Complex have illuminated cross-cutting inadequacies in the investigative methods, characterization and monitoring technologies, and predictive simulations conventionally used to quantify flow and contaminant transport in the vadose zone. These deficiencies are widespread throughout the DOE Complex and have led to questions of how to: 1) predict long-term performance, 2) design waste disposal sites, and 3) manage those sites. In response to these issues, DOE has launched the development of a complex program on vadose zone roadmapping. The integration of studies on radioactive and hazardous waste migration at chemical and nuclear waste disposal sites in Russia with the DOE program could offer a timely resolution to this pressing issue.

The goals of this project are to: (1) provide critical evaluation of the performance of long-term vadose zone flow and chemical transport characterization and monitoring technologies to be used in the DOE-Complex Vadose Zone Roadmap; (2) develop conceptual, mathematical and numerical models for two field sites (to be utilized jointly with the DOE); and, (3) conduct numerical modeling to simulate flow and contaminant transport in the vadose zone at two field sites to assess whether and how these field data can be used to build confidence in numerical models developed in the United States.

II. JCCES Technology Development & Deployment: Central & Eastern Europe

Introduction

The Joint Coordinating Committee for Environmental Systems (JCCES) was initiated in 1995 between the DOE Office of Environmental Management (EM) and the Institute for Ecology of Industrial Areas (IETU) in Katowice, Poland. The IETU is a research arm of the Polish Ministry of the Environment and is located in the upper Silesian region of southwestern Poland. This institute and this region of Poland offer unique opportunities for conducting environmental research, developing and demonstrating environmental remediation technologies and for implementing projects that result in bilateral benefits to the U.S. and Poland.

The overall objective of this joint international project is to assist the U.S. Department of Energy in meeting its environmental restoration and waste management goals. These goals are to be accomplished by developing and/or evaluating technologies that are safer, faster, more effective and less expensive than many of those currently in use, as well as by encouraging the introduction and use of U.S. environmental technologies and services outside of the United States.

At the same time, this project will provide Poland, as well as other countries in Central and Eastern Europe with exposure to and experience with U.S. site characterization, risk assessment and remediation methods and technologies. This will enable these countries to more effectively cope with their own environmental problems, which are often pervasive and widespread due to decades of environmental neglect.

As with the JCCEM, participation by the Environmental Management (EM) Office of Science and Technology (OST) and Office of International Programs of DOE (see http://www.em.doe.gov/) in the JCCES program ensures coordination between the Focus Areas and the JCCES. Projects are reviewed and evaluated by Focus Area technical staff for scientific merit, applicability to key DOE site needs, and for applicability the expressed needs of a DOE user. Funding for this program comes from the DOE Subsurface Contaminants Focus Areas (SCFA). Florida State University (FSU), through its Institute for International Cooperative Environmental Research (IICER) (www.iicer.fsu.edu) and the Science Applications International Corporation (SAIC), provide technical and organizational support to DOE for the JCCES program. IICER provides direct technical oversight for some JCCES projects, while providing coordination and administrative oversight to projects directed by PI s within the DOE complex.

The JCCES currently supports two major areas of research that address the remedial needs of the U.S. DOE and the technical expertise of the IETU:

> Organic contaminants in soil. Bioremediation is a technology well-suited to the remediation of soil that is contaminated with organic contaminants. The technology under development in Poland uses indigenous microbes adapted to low pH conditions combined with a unique aeration/leachate recirculation system to breakdown hydrocarbon contamination. This technology is to be deployed at DOE sites and at other sites in the U.S. with similar types of contamination.

Heavy metals in soil. Clean-up of heavy metal-contaminated soils is a major concern worldwide. Currently no feasible commercial methods exist for the cleanup of widespread contamination of this type. Phytoremediation is well suited for the remediation of moderate levels of heavy metals over large areas. These situations can be found at DOE sites, at other U.S. government sites and at commercial sites throughout the world.

The IETU offers unique opportunities for conducting environmental research as well as for developing, demonstrating and deploying environmental remediation technologies that result in bilateral benefits to the U.S. and Poland.

Success Stories and Recent Developments

This section presents some recent achievements of the JCCES program. The JCCES currently is conducting work for the Subsurface Contaminants Focus Area.

Bioreactors for organic contaminants in soil

In FY02, a project conducted under the U.S. Department of Energy s Joint Coordinating Committee for Environmental Systems (JCCES) will deploy a technology developed by the IETU that removes petroleum contamination from soil. The initial target for this deployment will be contaminated soils at the Savannah River Site. Petroleum contaminated soils are a widespread problem and remediation can be accomplished through a variety of technologies (including bioremediation). Soils contaminated with a combination of petroleum and low-level radioactive material, however, fall into the special regulatory category of Mixed Waste . Such soils require special management and do not currently have acceptable final disposal options. The Savannah River site currently is storing mixed waste soils in high level radioactive waste vaults. The IETU has gained valuable experience and expertise concerning the biodegradation of petroleum hydrocarbons through a multi-year JCCES project with Florida State University and the Savannah River Technology Center (SRTC). These efforts lead to the development of a portable bioreactor. The initial idea and design for a petroleum-contaminated soils bioreactor originated at the Savannah River Technology Center (SRTC). The IETU used the SRTC concept to construct, operate and optimize a bioreactor system in Poland. The knowledge and experience gained by the IETU was instrumental in the construction of a SRTC bioreactor to mixed waste remediate soils. The bioreactor system will allow SRTC to control microbial conditions, thereby optimizing the degradation of the petroleum component of the contamination. Bacterial strains with unique hydrocarbon degrading characteristics will be added to the system to accelerate the biodegradation process. These bacterial strains are isolated from the sludge disposal lagoons at a Polish oil refinery and have adapted to use petroleum hydrocarbons as carbon and energy sources. When the petroleum concentration in the soils is reduced below regulatory limits, the soil can be classified as low-level radioactive waste and permanently disposed of in slit trenches developed for this purpose. This not only provides a final disposal option for these soils, but also frees valuable vault space for other uses. Future plans for the bioreactor include automation and off-site monitoring capabilities. In addition, a bioreactor system for treating chlorinated solvent contaminated soil will be evaluated in FY02 at the IETU.

Michael Heitkamp (SRTC), Skip Chamberlain and Gerald Boyd (DOE OST) discuss IETU bioreactors with Dorota Rzychon, Adam Worsztynowicz and Krzysztof Ulfig (IETU). Chlorinated solvent bioreactor (yellow in foreground) and petroleum contaminated soils bioreactor (green in background)

Sebastian Iwaszenko (IETU) inspects sensor arrays installed inside the bioreactor.

Phytoremediation for lead-contaminated soil

In FY02, a project conducted under the U.S. Department of Energy s Joint Coordinating Committee for Environmental Systems (JCCES) and managed by Florida State University will deploy a phytoremediation technology developed by the IETU for removal of lead from soil. The initial target for this deployment will be one of several firing ranges at the Savannah River Site. Lead is a common industrial constituent and waste product. Advances in the understanding of the toxic effects of lead (particularly on children) have resulted in increasingly more stringent clean-up standards. The current baseline technology for remediating lead in soil is to excavate, transport and dispose of the contaminated soil. This approach is not cost-effective or practical for large areas and does not relieve the contaminated site of the liability for the disposed materials. Phytoremediation is a developing technology which has the potential to remove some heavy metals from soil and to concentrate them in the above ground portions of plants. The harvested plant material can be composted (to reduce volume) and recycled or disposed. During the last three years, the Institute for Ecology of Industrial Areas (IETU) in Katowice, Poland has developed and evaluated large-scale phytoremediation for removing lead from soil through plant uptake, subsequent plant harvesting and a variety of techniques for final disposition. This type of phytoremediation, known as phytoextraction, uses specially selected plants and standard agricultural techniques. At a predetermined point in the plant s developmental process, amendments are added to the soil (to enhance the mobility of lead) and to the plant (to enhance the uptake process). Over a period of a few days, plants take up lead from the soil and are then harvested. Major cost factors have been identified (i.e., costs of soil amendments) and reduced during the project. Modifications to the technology and the development and implementation of a soil amendment application control technology resulted in substantial reductions in process cost. The technology will be deployed at a firing range at the Savannah River Site. Future plans for this project include application to other heavy metals (e.g., mercury, chromium) and radionuclides as well as identification of other potential target sites within the DOE complex.

Phytoremediation field deployment site in southern Poland.

SRTC, FSU, Polish and Hungarian scientists meet at a Savannah River Site firing range. These discussions were precursors to planned FY02 deployment of phytoremediation at SRS.

Chlorophyll fluorometer for plant monitoring

In FY02, a project conducted under the U.S. Department of Energy s Joint Coordinating Committee for Environmental Systems (JCCES) and managed by Florida State University will deploy a plant monitoring technology developed by the Technical University of Budapest, Hungary. The initial target for this deployment will be data collection activities at the Savannah River site with ongoing phytoremediation and plant monitoring projects. The role of plants in environmental monitoring and remediation activities is expanding rapidly. A variety of phytoremediation technologies utilize plants to remove, degrade or stabilize environmental contaminants. In addition, plants are recognized as important bio-indicators of environmental impacts. However, few techniques exist for monitoring the status of plants. The Technical University of Budapest (TUB) has developed an instrument that is being commercialized by Central European Advanced Technologies (CEAT). This field-portable instrument measures plant stress as a function of chlorophyll fluorescence. The TUB/CEAT chlorophyll fluorometer measures a plant s ability to convert chlorophyll from the inactive (dark phase) form to the active (light phase) form. This process is known as Kautsky Kinetics. The speed and nature of this chemical change is an accepted measure of plant stress. Such measurements are being used in this project to optimize phytoremediation by detecting small changes in plant stress. A Kautsky Kinetics signature has been identified for one target plant species that correlates well with lead uptake. These measurements provide a real-time field indication of lead uptake by plants. Other possible uses for the instrument include conducting sensitive surveys of potentially contaminated sites for stressed vegetation and ground-truthing remote sensing data. TUB/CEAT is in the process of evaluating the technology for use with chlorinated solvent contamination. By identifying the chlorinated solvent concentrations that are associated with plant stress, decisions can be made in locating extraction points in a contaminated groundwater plume. Such information could be used to support ongoing activities for phytoremediation of chlorinated solvents at the Savannah River Site.

Michael Heitkamp (SRTC), Skip Chamberlain and Gerald Boyd (DOE OST) (from left) are briefed by Peter Richter (center) and Attila Barocsi of Central European Advanced Technologies on the chlorophyll fluorometer.

Chlorophyll fluorometer being deployed during a phytoremediation field demonstration in southern Poland

Conclusion

The numerous and growing successes of DOE JCCEM and JCCES programs demonstrate the rich opportunities related to the identification of new effective environmental technologies and scientific capabilities available in other countries which meet the needs of DOE site cleanup objectives. These programs also demonstrate innovative ways to reduce the costs and time frame associated with the development of new technologies, from the inception of a new idea to deployment within the DOE Complex. The International Programs established within the Office of Science and Technology clearly provide an effective complement to technology development and deployment using the technical capabilities available in the United States.

It is worthwhile to underline two important components of these programmatic successes. The first component is the well-organized coordination, communication and management of projects involving principal investigators and research teams from DOE and participating countries. These logistical and management challenges include the organization of working meetings, workshops and other activities that bring together DOE scientists with scientists from outside the U.S. to discuss the current status and future plans of cooperative projects. These collaborative activities are conducted in both the U.S. and the host countries in order to provide opportunities to learn more about the institutions, research facilities, working conditions and capabilities of project collaborators. The second success element involves the technical assistance provided by Florida State University to facilitate effective interactions between the research teams. This is particularly important in the earlier phases of project interactions. Florida State University has been responsible for providing technical support to principal investigators on a daily basis. The technical component is especially important when there is a significant language barrier. Both technical assistance and project management are very important at the initial stages of project implementation. The technical component helps to ensure the development of a bridge between the two technical teams to foster a clear understanding of the project objectives, limitations and, most importantly, how the project results can help to address specific DOE site problems most effectively.

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